4 Roadway Improvements

Bicycles will be ridden on all highways where they are permitted. As a result, all new highways, except those where bicyclists legally will be prohibited, should be designed and constructed under the assumption that they will be used by bicyclists. Bicycle-safe design practices, as described in this guide, should be followed to avoid costly retrofit improvements. Roadway conditions should be examined and, where necessary, such improvements as safe drainage grates and railroad crossings, smooth pavements and traffic signals responsive to bicycles should be provided.

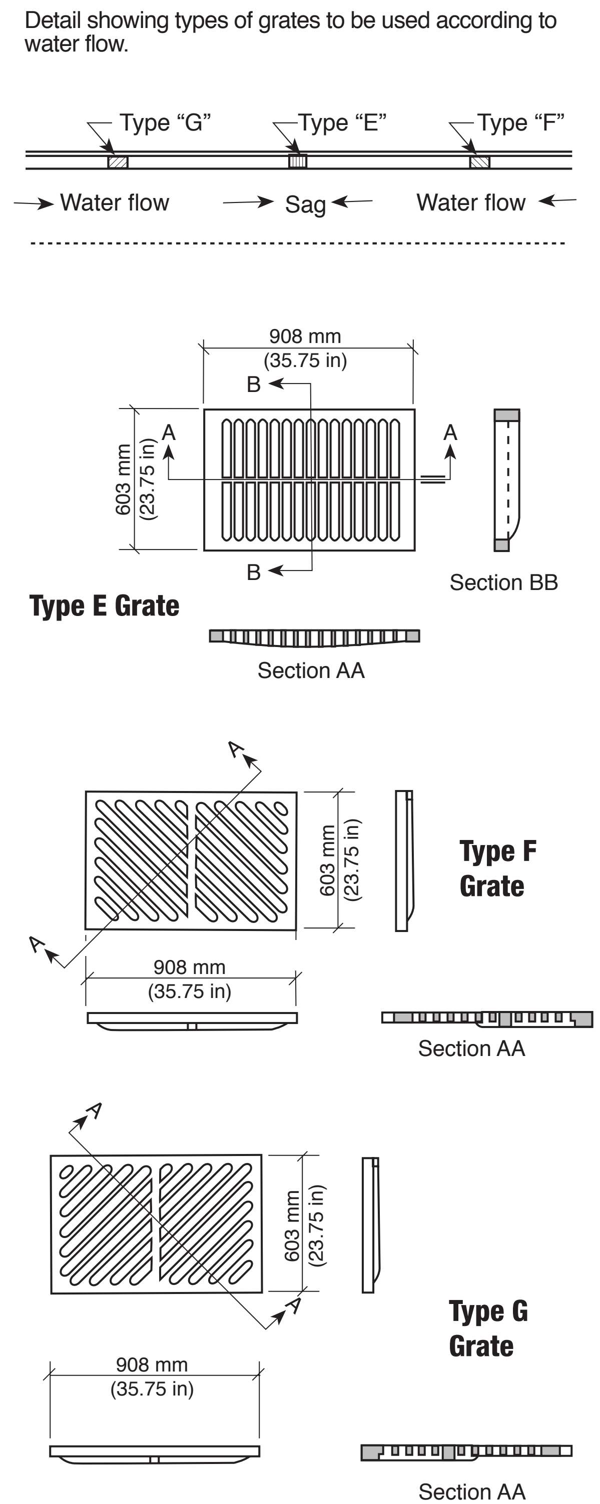


Figure 4-1: Bicycle-safe drainage grates approved by the North Carolina Department of Transportation.

Drainage grates

Drainage grate inlets and utility covers can be serious hazards to bicyclists. Unsafe grates can divert a cyclist's front wheel, causing a crash. Parallel bar drainage grate inlets are the most hazardous because they can trap the front wheel of a bicycle causing loss of steering control and the bar spacing is such that they can allow narrow bicycle wheels to drop into the grates, resulting in damage to the bicycle wheel and frame and/or injury to the bicyclist.

Grate cover replacement and retrofit: Unsafe grate covers should be replaced with either Type E, F or G standard grate covers as shown in Figure 4-1. For more complete details, refer to the *North Carolina Department of Transportation Roadway Design Manual, and Roadway Standard Drawings Manual*, std. no. 840.03.

Identifying a hazardous grate with a pavement marking, as indicated in the *Manual on Uniform Traffic Control Devices* (MUTCD), is generally unacceptable, especially with parallel bar grate inlets. Because of the serious consequences of a bicyclist's missing the pavement marking in the dark or being forced over such a grate inlet by other traffic, these grates should replaced as soon after they are identified as practicable.

Grates and resurfacing: Because bicycles are more sensitive than motor vehicles to pavement irregularities, during construction appurtenances should not be left projecting above the pavement surface.

Repeated resurfacings without adjusting the utility cover neck flange or drainage grate frames result in the covers being sunken below the pavement surface, a hazardous condition to bicycle traffic. Therefore, all manholes, inlets, lampholes and water valve boxes should be brought to grade by either lowering or raising as required in all new construction, reconstruction and resurfacing projects.

When a new roadway is designed, all grates and covers should be bicycle safe. Gutters designed for flow to curb-opening inlets are not considered ridable because of the warping of the gutter for drainage. Such warping may result in adverse handling effects.

Railroad crossings

For bicycle traffic, there are two main problems with at-grade railroad crossings. First, if the tracks cross the roadway at less than 45 degrees, a bicyclist's front wheel may be diverted by the rail or trapped in the flangeway, causing loss of steering control. Second, a rough crossing – regardless of angle – may cause wheel damage or may cause a bicyclist to crash.

Angled crossings: When railroad tracks cross highways or bikeways at-grade, they should do so as close to a right angle as possible. If this is not possible, consideration should be given to the following options:

(1.) As shown in Figure 4-2, widening the approaching roadway, bike lane or shoulder will allow the bicyclist to cross at approximately 90 degrees without veering into the path of overtaking traffic. The minimum amount of widening should be 1.8 m (6 ft); however, 2.4 m (8 ft) is desirable, depending on the amount of available right-of-way. Adequate tapers should be provided.

(2.) On low-speed, lightly-travelled railroad tracks, commercially available flangeway fillers can eliminate the gap next to the rail (see Figure 4-3). The filler normally fills the gap between the inside railbed and the rail. When a train wheel rolls over it, the flangeway filler compresses. This solution, however, is not acceptable for high-speed rail lines, as the filler will not compress fast enough **and the train may derail.**

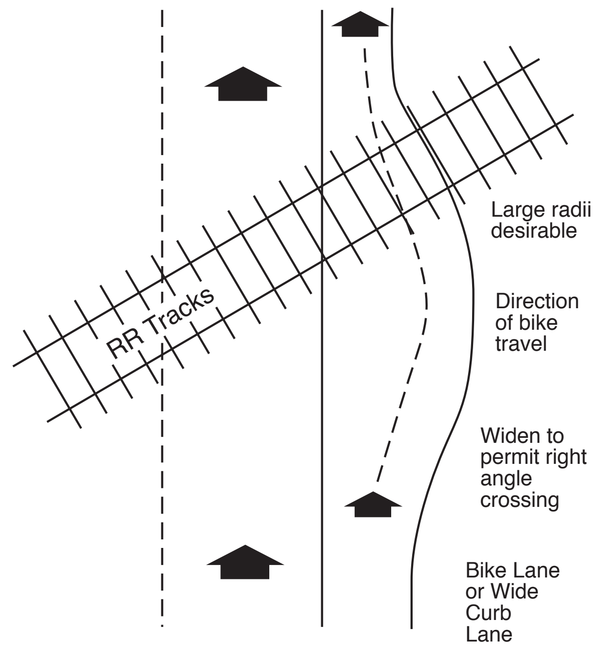


Figure 4-2: Flared roadway permits bicyclists to cross angled railroad crossing at or near 90 degrees.

Source: AZ Bicycle Facilities Planning & Design Guidelines; AZDOT, 1988

(3.) In some cases, abandoned tracks can be removed, completely eliminating the problem.

(4.) If no other solution is available, warning signs and pavement markings should be installed in accordance with the MUTCD. While there is no approved sign for this specific situation, a W11-1 warning sign with an appropriate subplate message (e.g., BIKES CROSS AT RIGHT ANGLE) may provide sufficient warning for bicyclists.

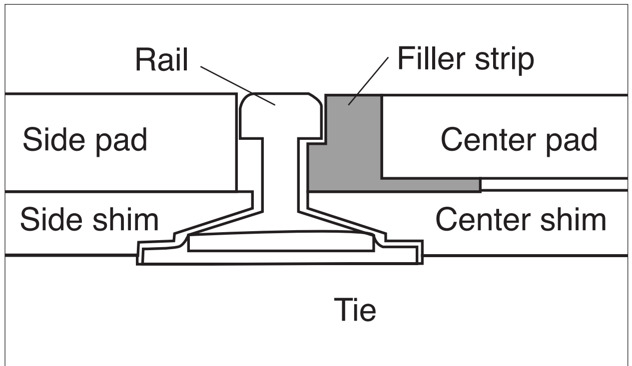


Figure 4-3: Cross section of rubberized railroad crossing with flangeway filler strip for low-speed angle crossings.

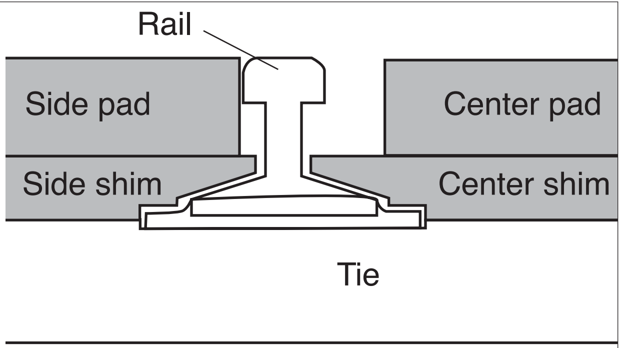


Figure 4-4: Cross section of rubberized railroad crossing for rough perpendicular crossings.

Rough perpendicular crossings: Rough and uneven timber or paved perpendicular crossings can cause control problems and equipment damage for bicyclists. Regular maintenance and replacement, if necessary, can solve the problem. However, in some cases the best long-term solution is to install a rubberized crossing (see Figure 4-4). Such crossings generally consist of a concrete base with a rubberized surface. While these are relatively expensive to install, there are significant savings in long-term maintenance costs because of their stability.

Pavement quality

Pavement surface irregularities can do more than cause an unpleasant ride. While automobile suspensions can compensate for surface roughness and potholes, and wide tires can span cracks, bicycles, with their narrow tires and lack of suspension, have difficulty handling such hazards. Gaps between pavement slabs or drop-offs at overlays parallel to the direction of travel can trap a bicycle wheel and cause loss of control. Holes and bumps can cause bicyclists to swerve into the path of motor vehicle traffic. To the extent practicable, pavement surfaces should be free of irregularities.

The right lane or shoulder generally should be uniform in width. While skilled bicyclists guide off the lane stripe and ride a predictable straight line, many riders will move right or left depending on the width of the lane or presence of shoulders. A road which varies widely in width will encourage such unpredictable behavior.

On older pavements it may be necessary to fill joints, adjust utility covers or, in extreme cases, overlay the pavement to make it suitable for bicycling. See *Drainage Grates* (page 21) for guidance on grates and utility covers.

When new pavement overlays are added to curb and gutter sections, the new asphalt should be feathered to allow the new surface to meet the gutter pan smoothly. Failure to feather the new overlay into the existing pavement can result in a hazardous longitudinal lip at the edge of the new asphalt. In some cases, the old pavement may need to be milled. Generally, paving over a concrete gutter is not satisfactory for several reasons: (1) the joint line will probably come through the new asphalt, causing a longitudinal crack, (2) paving to the curb may affect the drainage and lower the effective height of the curb.

Chip sealing a road extends the life of the pavement at relatively low cost. However, the process can cause bicyclists serious problems. When applying chip seal coats to existing streets, removal of excess gravel at the earliest possible convenience is important. Since passing motor traffic sweeps the gravel off to the side of the road, the gravel tends to collect in piles high enough to cause bicyclists to crash. For this reason, bicyclists will often ride in the area cleared by motorists' tires. Also, chip sealing tends to roughen the surface and is not the preferred treatment for roads where bicycle traffic is to be encouraged.

Slurry seal, on the other hand, can provide a smooth surface to a previously rough shoulder or lane. While it should only be applied to sound pavement, it is an inexpensive treatment for improving the surface for bicyclists. As with chip sealing, any extra material should be removed as soon as possible.

Traffic control devices

Bicycles should be considered in the selection and provision of traffic control devices. While most traffic signs apply equally to motorists and to bicyclists, bicyclists have special needs in two primary areas: (1) signal timing and actuation and (2) bicycle-related signing and marking.

Traffic signal timing: Bicycles should be considered in the timing of traffic signal cycles and in the choice of a traffic detection system. An average bicyclist can cross an intersection under the same signal phasing arrangement as a motor vehicle. However, on multi-lane streets, clearance intervals should be long enough to allow bicyclists to cross. If necessary, an all-around-red-clearance interval may be used. To check the clearance interval, use a bicyclist's speed of 16 km/h (10 mph) and a perception/reaction/ braking time of 2.5 seconds.

Signal actuation: Detectors for traffic-actuated signals should be sensitive to bicycles and should be located in the bicyclist's expected path, including left turn lanes. The preferred options for loop detectors are as follows (see Figure 4-5):

(1) In shared roadway situations, where the exact location of the bicycle cannot be easily predicted, the diagonal quadrupole loop is best, since it is bicycle-sensitive over its entire width while being relatively immune to false calls caused by motor vehicles in adjacent lanes.

(2) In bicycle lane or bicycle path situations, where the location of the bicycle can be easily predicted, a quadrupole detector works well. The quadrupole loop is highly sensitive over the center wires, less sensitive over the outer wires and relatively insensitive to motor vehicles in adjacent lanes.

(3) Standard loops are the least desirable for sensing bicycles. These loops are square or rectangular in shape and are most sensitive over the wires that form the outer boundary of the loop. While some are sensitive enough directly over the wires to detect bicycles, the bicyclist must know just where to stop, and why it's important to stop there.

For this reason, standard loops are the least desirable and should be used only in locations where bicycle traffic is not expected. Some standard loop/amplifier combinations cannot be adjusted to reliably detect bicycles without detecting motor vehicles in adjacent traffic lanes. These loops should be replaced with bicycle-sensitive models.

In special cases, pedestrian activated buttons may be mounted near the curb for bicycle use. This approach may be useful where a bicycle path crosses a highway, for example.

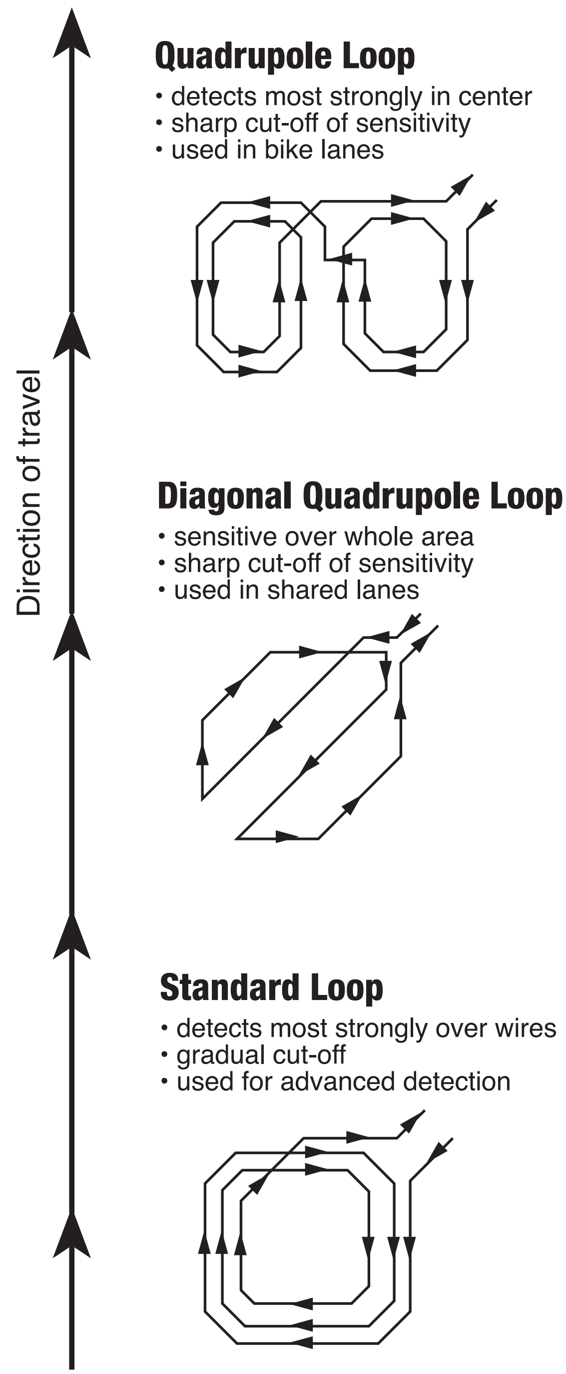


Figure 4-5: Recommended loop types for bicycle detection. In most shared-road situations, the diagonal quadrupole is preferred.

Source: Traffic Signal Bicycle Detection Study; City of San Diego, 1985

However, in most roadway situations, the need for bicyclists to position themselves at intersections according to their destinations (e.g., in left-turn lanes or to the left of a right-turn-only lane) makes such push buttons the least desirable option.

Programmed visibility heads: Where programmed visibility signal heads are used, they should be checked to ensure that they are visible to bicyclists who may be positioned near the right edge of the roadway.

Signing and marking: The following guidance from the MUTCD should be followed when installing signing or marking for bicycles:

"Traffic control devices, whether they are intended for motorists or bicyclists, must adhere to five basic requirements to be able to perform their intended function. They must

1. Fulfill a need.
2. Command attention.
3. Convey a clear, simple meaning.
4. Command respect of road users.
5. Give adequate time for proper response."

Part IX of the MUTCD, reproduced in Appendix 4, should be consulted for guidance on bicycle signs and pavement markings. Where bicyclists are expected to use different routings than motorists, directional signing should be used to confirm to bicyclists that the special routing leads to their destination. Bike route signs are discussed in Chapter 6, bike lane signs are discussed in Chapter 5, and bike path signs are discussed in Chapter 7, with further details given in Part IX of the MUTCD or in Part IX of the *Traffic Control Devices Handbook*. Other signs used specifically in North Carolina are discussed in Appendix 5.

Structures

Structures like bridges and tunnels can provide key links in any bicycle transportation system. Since they are often expensive to build or modify, structures tend to be replaced less often than sections of roadway by comparison and they tend to be relatively narrow. However, because they often connect networks of local roads on either end, improving a structure, or considering bicyclists' needs in the construction of a new one or renovation of an existing one, can provide significant benefits for bicycle users.

The priority an agency places on providing bicycle-related improvements in any specific case should be based on consideration of the following factors.

Traffic conditions:

Bicycle traffic volume (potential or actual): A structure on a popular bicycling route is a better candidate than one on a road with little or no potential for bicycle use.

Bicycle crash experience: Given that relatively few serious bicycle crashes are reported to the police, a structure with a history of reported bicycle crashes may be the site of many unreported crashes as well. As a result, it should receive close scrutiny.

Motor vehicle traffic volume: A high-volume structure is more likely to need bicycle accommodations than a low-volume one, due to the increased likelihood of conflicts.

Percent of truck and/or RV traffic: A structure with a high percentage of truck and/or RV traffic is more likely to need bicycle accommodations than one with little or no such traffic.

Traffic speed: High traffic speeds (i.e., over 70 km/h (45 mph)) are associated with a significant percentage of bicycling fatalities and structures on such routes need close attention.

Land use and the transportation system:

Proximity to bicycle traffic generators: A structure that serves many nearby residents and connects to popular recreation or commercial areas is likely to attract more bicycle use than one far away from any community.

Alternate routes: If there are no suitable alternate routes, the importance of a particular structure will be greater than if there are numerous options.

Connecting roadways: If the structure connects segments of freeway or expressway, it is less likely to be in demand than one that connects surface streets, like collectors or arterials.

Bicycle accommodations: A structure that connects existing or planned bicycle facilities (e.g., bicycle lanes or routes) is a good candidate for bicycle-related improvements.

The structure's geometrics:

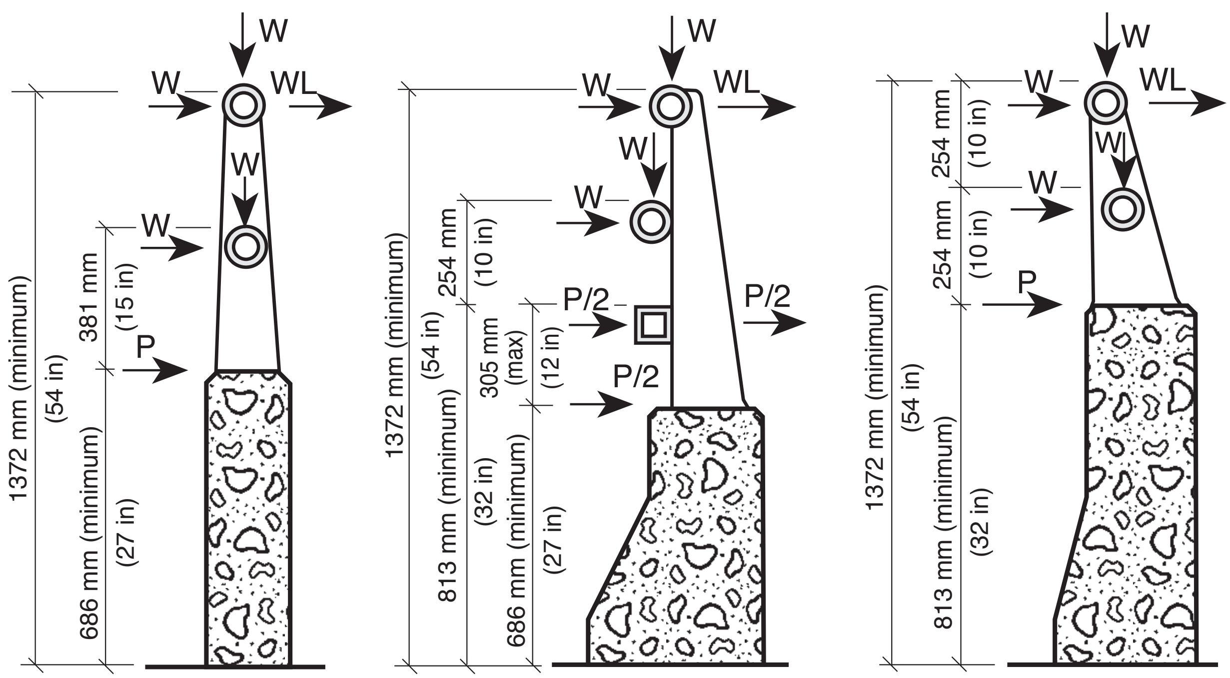
Elevation: Fixed span bridges that arch high for the passage of ships are less attractive for most bicyclists than are flatter structures. However, on steep structures, the presence of slow-moving bicyclists on the ascent and fast moving bicyclists on the descent must be considered. Wider shoulders to accomodate conditions may be appropriate.

Width: Because passing opportunities are more limited on two-lane structures than on multi-lane structures, the former structures are more likely locations for bicycle/motor vehicle conflicts.

Bridges

Improving a bridge for bicycle use involves analyzing four major areas of concern: (1) static obstructions, (2) surface conditions, (3) bridge deck width, and (4) bridge approaches.

Static obstructions: Bicycle-safe bridge railings (Figure 4-6) shall be used on bridges specifically designed to carry bicycle traffic, and on bridges where specific protection of bicyclists is deemed necessary. Bicycle rails



Notes:

1. Loadings on left are applied to rails.
2. Loads on right are applied to posts.
3. The shapes of rail members are illustrative only. Any material or combination of materials listed in Article 2.7 of Standard Specifications for Highway Bridges (AASHTO, 1989) may be used in any configuration.

Nomenclature:

P = Highway design loading
h = Height of top of top rail above reference surface
L = Post spacing
w = Bicycle loading per unit length of rail

Figure 4-6: Combination traffic and bicycle bridge railings. A railing height of 1372 mm (54 in) will protect bicyclists from toppling over.

Source: AASHTO Standards & Specifications for Highway Bridges, 1989 used on highway bridges shall be in acordance with the latest American Association of State Highway and Transportation Officials (AASHTO) specifications and shall be crash-tested in accordance with Federal Highway Administration (FHWA) guidelines. The minimum height of a railing used to protect a bicyclist shall be 1,372 mm (54 in), measured from the top of the riding surface to the top of the rail. In cases where existing railings are below this height, consideration should be given to retrofitting an additional bicycle railing to the top, bringing the total height to 1,372 mm (54 in).

Guardrails on bridge approaches should be designed with the needs of bicyclists in mind. As a general rule, a roadside barrier should be placed as far from the traveled way as conditions permit. A minimum offset from the edge of the traffic lane or paved shoulder of 1.2 m (4 ft) is desirable. In situations where the slope on the far side of the guardrail is excessive or the hazard serious, or where the shoulder or outside lanes are narrow, consideration should be given to attaching a bicycle-safe railing to the top of the guardrail. This will bring the total height to 1,372 mm (54 in).

Surface conditions: On all bridge decks, special care should be taken to ensure that smooth bicycle-safe expansion joints are used. In cases where joints are uneven, rubberized joint fillers or covers may be considered.

The bridge deck should not pose a hazard for bicyclists. Only bicycle-safe grates and drains should be used. Steel decking on draw bridges or swing bridges can cause steering difficulties for bicyclists. In general, such bridges should not be signed as bicycle facilities without determining the deck's effect on bicycle handling.

The accumulation of roadside debris may cause problems for bicyclists, forcing them to ride farther out from the right edge than many would prefer. Regular maintenance, particularly in the right half of the outside lane and on paved shoulders, is important.

Bridge deck width: Two primary options are available for accommodating bicyclists on highway bridges (see Figure 4-7). First, 1.2 m (4 ft) (minimum) shoulders may be added to each side. Second, a widened outside lane at least 4.2 m (14 ft) wide may be used on each side of curb and gutter sections. In deciding between these options, the primary considerations are traffic speed and volume.

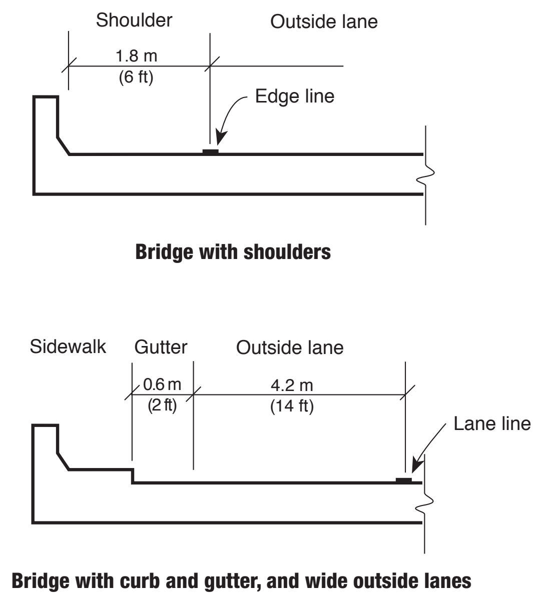


Figure 4-7: Suggested widths for bicycle accommodations on bridges.

On bridges with higher posted speeds, the effects of windblast described in FHWA research (Figure 4-8) may be offset by providing a separation distance between bicyclists and passing vehicles. This is particularly important where a significant percentage of truck or RV traffic is present; in such cases, additional width beyond the recommended 1.2 m (4 ft) of paved shoulder is useful. On bridges with lower posted speeds, windblast effects are not particularly serious, and, hence, widths are determined more by physical clearances.

Bridge approaches: Bicycle provisions, whether shoulders or wide outside lanes, should continue for at least 30 m (100 ft) on either side of the bridge in order to ensure a safe transition. If on- or off-ramps or intersections are present, shoulders or wide outside lanes should continue at least as far as the ramps or intersection.

On lower-speed bridges and ramps, the crossing is similar to that used for turn lanes and the extra width should simply be added to the right-most through lane. On high-speed bridges and ramps, the shoulder striping should not cross over the ramp, but should follow the ramp. Another shoulder stripe should pick up on the far side of the ramp.

If bicycle lanes are used, they should be designed as described in Chapter 5. On low-speed bridges, the bicycle lane stripe should be dropped before the ramp and picked up after, as shown in Figure 5-4(1) and Figure 9-5 in the MUTCD.

Tunnels, underpasses and interchanges

Tunnels, underpasses and interchanges may cause difficulties for bicycle users because of the grades involved, pavement widths and surface, and levels of lighting. Like bridges, these structures tend to be long-term investments and are not replaced or upgraded as often as connecting roadways. For this reason, they may act as barriers for bicycle travel.

Providing adequate width is important for safety, particularly on high-volume roads and highways. When traffic speeds are low, this may be done through the use of wide curb lanes. In high-speed tunnels, the preferred solution is a minimum 1.2 m (4 ft) wide outside shoulder.

Debris can build up at the right edge of the roadway and if the tunnel is not well lighted, bicyclists going from daylight to relative darkness may not immediately see the hazard. For this reason, providing adequate lighting and regular maintenance are important for bicyclists' safety.

If a high-speed tunnel or underpass is particularly narrow or contains a serious sight obstruction, then the structure may not be appropriate for bicycle use. Alternate routes should be investigated. However, there may be some circumstances where

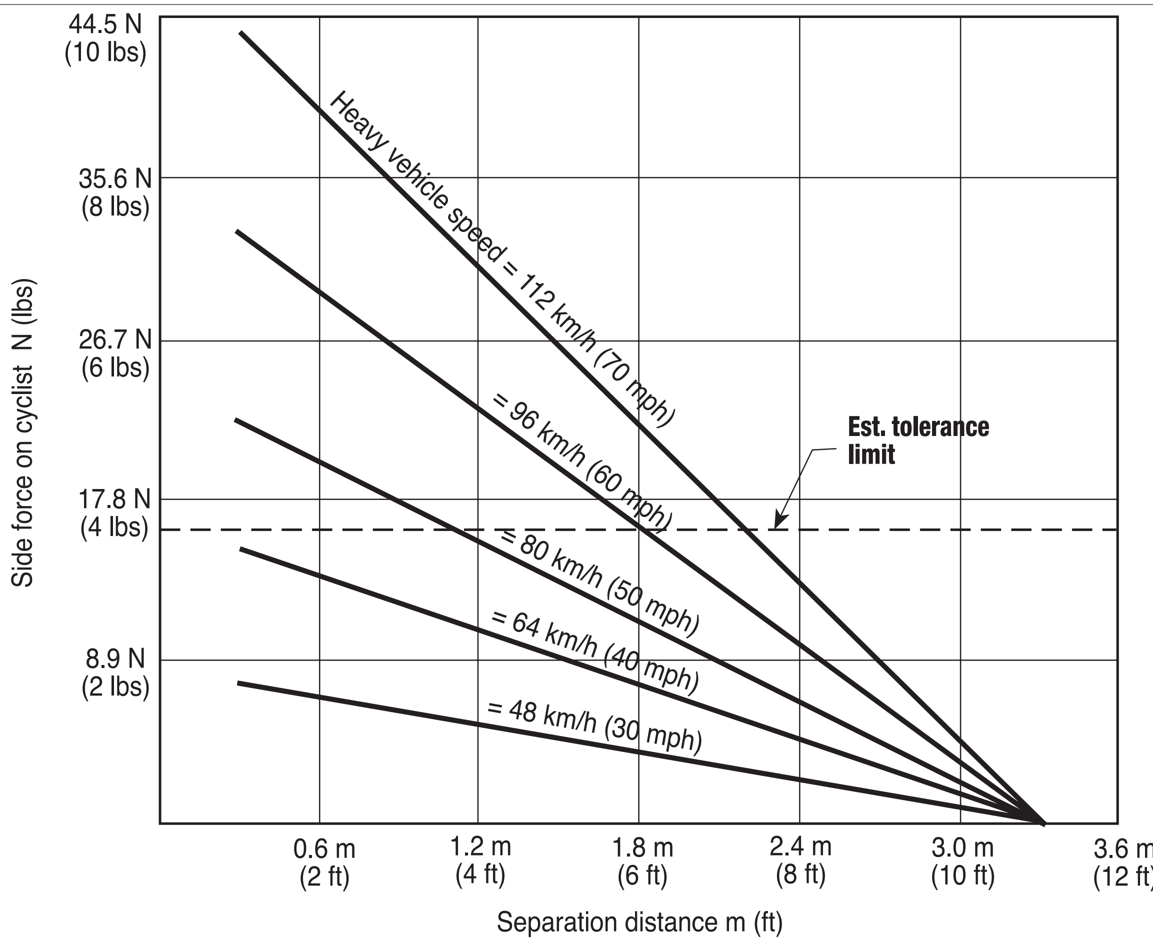


Figure 4-8: Aerodynamic forces caused by heavy motor vehicles passing bicyclists.

Source: A Bikeway Criteria Digest; USDOT Federal Highway Administration, 1977.

bicyclist-actuated flashing lights may be used to warn motorists of the presence of bicyclists in the tunnel or underpass. These lights flash for a given period of time after a bicyclist hits the button, warning motorists of his or her presence ahead.

If the tunnel or underpass is below the normal grade of the connecting roadway, any extra width should be provided on the climbing side of the roadway, since bicyclists will be going slower as they exit.

Shoulders

On urban streets, wide outside through lanes and bicycle lanes are usually preferred over shoulders for bicycle use. In rural areas or on roads with relatively few driveways and intersections, smoothly paved shoulders are preferred by many bicyclists. Shoulders also benefit motor vehicle traffic. Generally, the slope of the roadway should continue across the shoulder.

According to AASHTO's *Policy on Geometric Design of Highways and Streets*, paved or stabilized shoulders provide (1) usable area for vehicles to pull onto during emergency situations, (2) elimination of rutting and dropoff adjacent to the edge of travel lane, (3) adequate cross slope for drainage of roadway, (4) reduced maintenance and (5) lateral support for roadway base and surface course.

Where funding is limited, adding or improving shoulders on uphill sections first will give slow-moving bicyclists needed maneuvering space and decrease conflicts with faster-moving motor vehicle traffic.

Width: If it is intended that bicyclists ride on shoulders, the paved surface must be at least 1.2 m (4 ft) in width (Figure 4-9). If motor vehicle speeds exceed 60 km/h (35 mph); if the percentage of trucks, buses and recreation vehicles is high; or if static obstructions exist at the right side, then additional width is desirable (see Figure 4-8).

Clearances: Clearance from the edge of pavement to the plane of the foreslope of a ditch should be 0.6 m (2 ft) minimum (Figure 4-9). If the slope is greater than 2:1, the clearance should be 0.9 m (3 ft). If a guardrail is provided adjacent to the paved shoulder, a clearance from the edge of pavement of 1.2 m (4 ft) is preferred. Road signs and other vertical obstructions should be offset 1.8 m (6 ft) minimum from edge of pavement.

Pavement quality: Shoulders should be smoothly paved and have adequate strength and stability to support occasional motor vehicle tire loads under all weather conditions without rutting or other surface variations. The thickness of shoulder paving should be based on usual design consideration appropriate for each situation, although full-depth pavement is recommended with few exceptions.

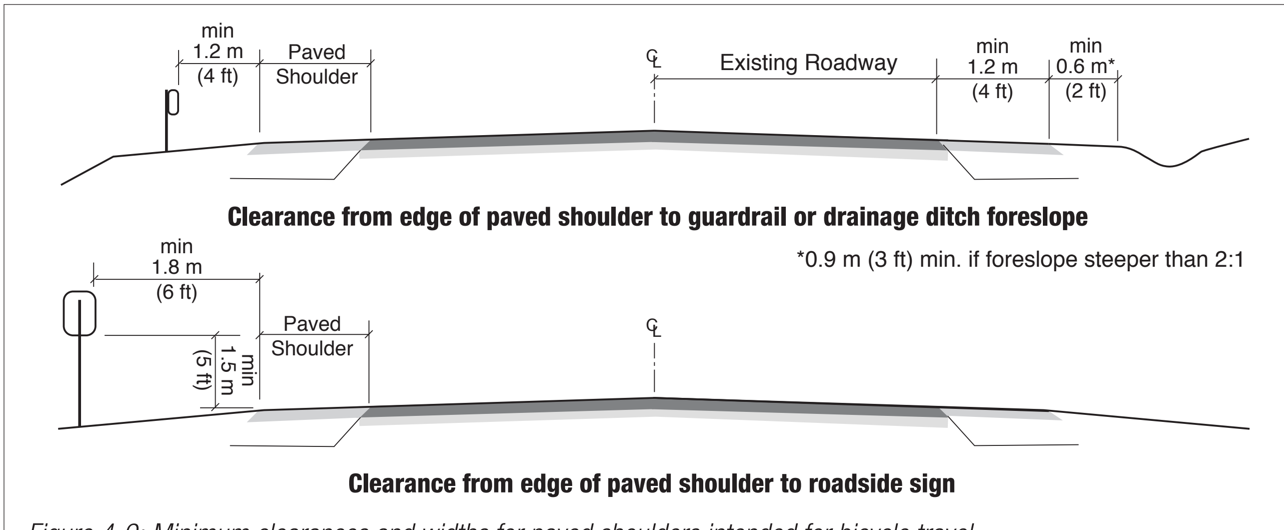


Figure 4-9: Minimum clearances and widths for paved shoulders intended for bicycle travel.

Note: See NCDOT Roadway Design Manual; in some cases values from Section 1-4B will govern.

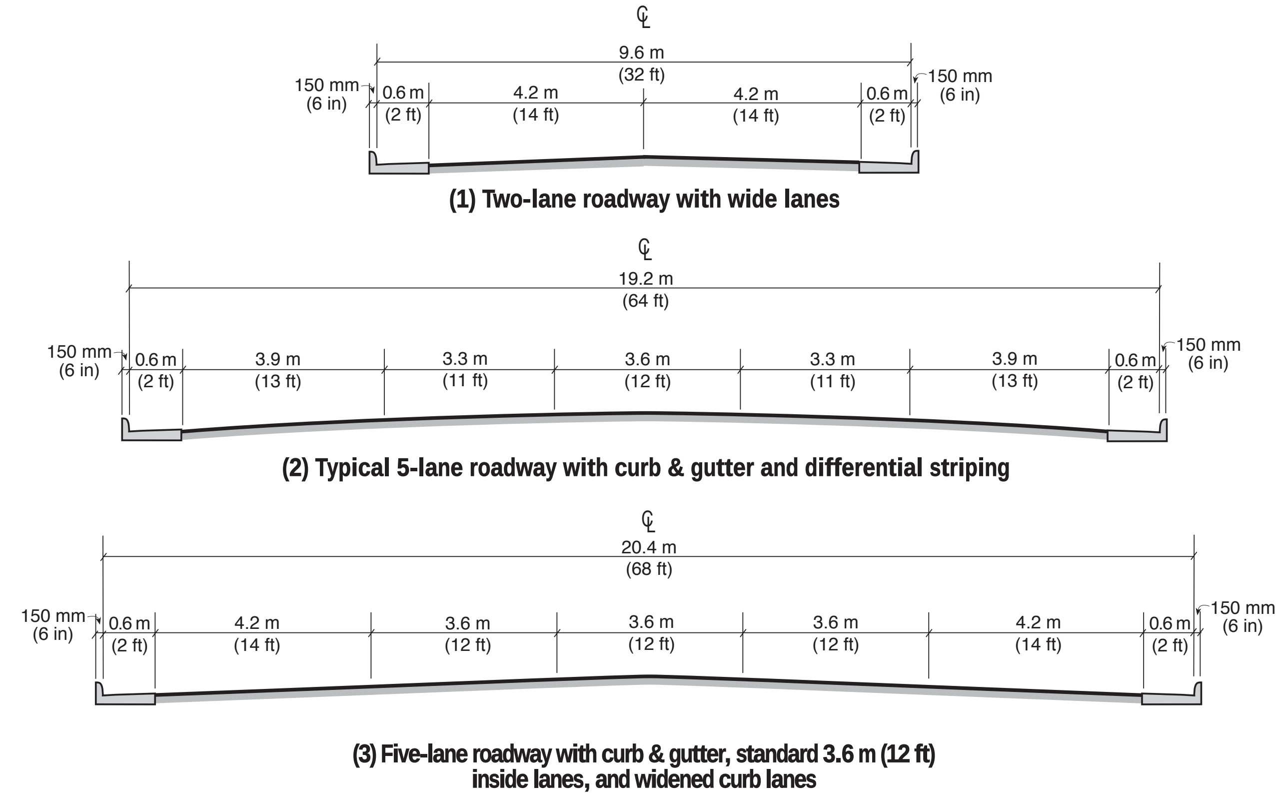


Figure 4-10: Options for creating wide outside lanes for bicycle traffic in different situations.

When it is necessary to add paved shoulders to roadways for bicycle use, paving an asphalt panel 3 m (10 ft) in width is preferred. This eliminates a joint at the edge of the existing pavement and allows the new asphalt to feather into the existing pavement between the motor vehicle wheel tracks. It provides a smooth and visually appealing improvement. White pavement edge lines, 100 mm - 150 mm (4 in to 6 in), should be used to delineate the shoulder from the motor vehicle lanes.

Rumble strips

Rumble strips and other devices designed to alert sleepy motorists can be a danger to bicyclists traveling on shoulders or near the right edge of the roadway. Where bicycle traffic is allowed, asphalt concrete dikes, raised traffic bars or other similar devices should only be considered on shoulders of roads where there is a well-documented safety problem.

In cases where rumble strips are used, additional shoulder width may be provided on the right side of the rumble strip.

Wide outside lanes

The desirable motor vehicle lane width is 3.6 m (12 ft). On roadways without separate bicycle lanes, a right-hand (outside) through lane wider than 3.6 m (12 ft) can better accomodate both bicycles and motor vehicles. The additional width on the outside lane also improves sight distances and provides more maneuvering room for vehicles turning into the roadway. In many cases where there is a wide outside through lane, motorists will not need to change lanes to pass a bicyclist. Thus, on roadways with bicycle traffic, widening the outside lane can have a beneficial effect on capacity.

Width: On roadways that accomodate both bicycles and motor vehicles within the travel lanes, 4.2 m (14 ft) of usable width should be provided on the outside through lanes. Studies have shown that any additional width on outside through lanes is beneficial. In determining the usable width of an outside lane, adjustments need to be made for obstructions. Bicyclists shy away from obstructions such as drainage gates, parked vehicles and longitudinal ridges between the pavement and gutter sections. An extra 0.3 m (1 ft) of "shy distance" should be added for flush or depressed obstructions, such as a joint or soft shoulder. If a raised obstruction, such as a curb and gutter, is present, an extra 0.6 m (2 ft) "shy distance" should be added to the raised face of the curb. If drainage grates are located in the gutter or near the right edge of the roadway, they should not be included in the calculations of usable width.

Some experts have recommended 4.5 m (15 ft) of usable width for an actual "wide outside through lane." However, widths greater than 4.2 m (14 ft) can encourage the operation of two motor vehicles in one lane. This is likely to occur near intersections with heavy turn volumes during periods of peak congestion. Such conditions may reflect a need to consider improvements at the intersection. At intersections with separate right-turn lanes, the outside through lane should be widened to accomodate bicycles.

The additional width for wide outside lanes to accomodate bicycle traffic should be introduced by widening the roadway pavement. However, on multi-lane roadway sections, if the outside lane width cannot be increased by widening the pavement, the lane striping may be shifted to narrow the inside lane(s) while widening the outside lane. No inside lane width should be reduced to less than 3.3 m (11 ft) for this purpose. Narrowing an inside lane from 3.6 m to 3.3 m (12 ft to 11 ft) can reduce the lane's capacity up to 5 percent. When considering this approach, the volume of truck traffic should be taken into account. In general, 3.3 m (11 ft) lanes should not be considered if the truck volumes are greater than 5 percent of the total traffic volume.

Two-lane roadways: A 4.2 m (14 ft) usable lane width is desirable to accommodate both motor vehicles and bicycles within the travel lanes. Figure 4-10 (1) shows the recommended typical section for a two-lane curb and gutter roadway when bicycles share the travel lanes with motor vehicles.

Multi-lane roadways: For curb and gutter roadway sections in urban and suburban areas, with more than one lane in each direction of travel, unequal lane widths with widened outside "curb" lanes are desirable to accommodate bicycles when the following conditions apply;

(1.) Control of access is not provided.

(2.) Motor vehicle traffic is not more than 60 percent (Level of Service C) of the route's capacity. (If greater than 60 percent, alternate bicycle accomodations should be considered, if feasible).

(3.) A minimum width of 3.3 m (11 ft) can be provided on each inside lane.

(4.) Truck traffic is not greater than 5 percent of the total motor vehicle traffic.

Existing facilities: Widening outside lanes to accommodate bicycles can be provided by introducing unequal lane width pavement markings on existing multi-lane facilities. When the above conditions are applicable, unequal lane width pavement markings should be introduced to existing curb and gutter facilities. This is best accomplished when the facility is resurfaced. Figure 4-10 (2) shows the prefered location for unequal lane width pavement markings to accommodate bicycle traffic on an existing five-lane, 19.2 m (64 ft), face-to-face curb and gutter section commonly used in North Carolina.

New facilities: Outside lanes that are 4.2 m (14 ft) wide should be constructed on new multilane curb and gutter facilities when bicycle traffic is anticipated and the above conditions are applicable. Figure 4-10 (3) shows the preferred typical section with appropriate pavement markings to accommodate bicycle traffic on a new curb and gutter roadway.